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Predictors of Adolescent E-cigarette Use

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in conjunction with the
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Predictors of Adolescent E-cigarette Use

by

Denise Dao Tran

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A Thesis submitted in partial satisfaction of
the requirements for the degree
Doctor of Philosophy in Clinical Psychology

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September 2016

Each person whose signature appears below certifies that this thesis in his/her opinion is adequate, in scope and quality, as a thesis for the degree Doctor of Philosophy.

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ABBREVIATIONS

CDC   Centers for Disease Control and Prevention

FDA   Food and Drug Administration

OR   Odds Ratio

CI   Confidence Interval

ABSTRACT OF THE THESIS

Predictors of Adolescent E-cigarette Use

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Doctor of Philosophy, Graduate Program in Clinical Psychology
Loma Linda University, September 2016
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E-cigarette use among adolescents in the U.S. has recently tripled. Studies suggest that e-cigarettes may be as addictive as conventional cigarettes, and that adolescents may be at particular risk for nicotine addiction, as well as for the neurological, developmental, and behavioral problems caused by nicotine use. The objective of the present study was to identify potential risk factors for adolescent e-cigarette use, particularly those related to conventional cigarette smoking. Respondents ($N = 177$; Mean age = 13.23 years; SD_{age} = 0.90; 60.00% female) were recruited from one public middle school and one public high school in Southern California, and completed an in-class survey on smoking and its correlates. A hierarchical logistic regression analysis was used to test attitudes toward cigarette addiction, perceptions of the risks and benefits of cigarette smoking, perceptions of the consequences of cigarette smoking, and exposure to anti-tobacco information as predictors of lifetime e-cigarette use after controlling for cigarette smoking experience. Previous smoking experience and perceived benefits of cigarette smoking significantly predicted the odds of being a lifetime e-cigarette user ($OR = .000$, $p < .01$ and $OR = 1.141$, $p < .05$, respectively). When exposure to information about the dangers of smoking was taken into account, the effect of perceived benefits was no longer statistically significant, but its effect size implied clinical significance. Although negative

physical feelings, social facilitation, and exposure to information about the dangers of smoking did not have statistically significant effects on lifetime e-cigarette use, their effect sizes also implied clinical significance. Attitudes toward cigarette addiction and perceived risks did not predict lifetime e-cigarette use. Prevention programs should be tailored toward adolescents with previous cigarette smoking experience, be designed to address any false perceptions that conventional cigarette smoking may be beneficial or facilitate social benefits, and include information that e-cigarettes have similar negative health effects as conventional cigarettes. Officials should consider regulatory actions that have been effective in preventing conventional cigarette smoking among youth, such as implementing an excise tax or banning flavored cigarettes. Future researchers should examine the relationship between adolescents' beliefs about the safety of e-cigarettes and e-cigarette use and evaluate possible predictors of the frequency of e-cigarette use.

Keywords: Adolescents, E-cigarettes, Cigarette smoking

CHAPTER ONE

INTRODUCTION

Adolescence is the developmental period in which nicotine use typically begins (Backinger, Fagan, Matthews, & Grana, 2003; Chassin et al., 2008; Lantz, 2003; Slotkin, 2002). Electronic cigarette use among adolescents in the U.S. has increased at an alarming rate over the past few years and has become the most widely used tobacco product among youth, including conventional cigarettes (CDC, 2015). Results from an online survey taken by 228 males 11 to 19 years indicated that 67% had heard of e-cigarettes, and those between the ages of 14 and 19 years reported the highest rate of e-cigarette awareness (Pepper et al., 2013). Given that awareness of e-cigarettes also increases the risks of initiating use (Carroll Chapman & Wu, 2014), these findings suggest that older adolescents who are more aware of e-cigarettes may be at particularly high risk for initiating e-cigarette use simply due to increased awareness.

Research also suggests that initiation of e-cigarette use may place adolescents at risk for initiating use of traditional combustible cigarettes. In a longitudinal study among 14-year-old adolescents, students who reported lifetime e-cigarette use at baseline were more likely to report initiating use of a combustible tobacco product at the six- and 12-month follow-up periods (Leventhal et al., 2015). These researchers also found that e-cigarette use at baseline was associated with initiation of combustible cigarette use during these two follow-up time points. Given that initiation of nicotine use during adolescence is associated with increased risk for long-term dependency (Chambers, Taylor, & Potenza, 2003; Kendler et al., 2013; Klein, Sterk, & Elifson, 2013), targeting adolescents in the prevention of e-cigarette use should be a priority for public health authorities.

According to the Centers for Disease Control and Prevention and the U.S. Food and Drug Administration's Center for Tobacco Products, e-cigarette use among adolescents has tripled in just one year (CDC, 2015). From 2013 to 2014, findings from the National Youth Tobacco survey indicated that current e-cigarette use (use within the last 30 days) among middle school students more than tripled from 1.1% to 3.9%, which is an increase from approximately 120,000 to 450,000 adolescents nationwide (CDC, 2015). Among high school students, past month e-cigarette use increased from 4.5% to 13.4% in the same period, which is an increase from approximately 660,000 to two million high school students (CDC, 2015). These increases have sparked concern among advocates of tobacco control who warn that these increases in use among middle and high school students may produce a future generation of individuals with issues of nicotine dependence (CDC, 2015). Therefore, it is important to identify which adolescent characteristics predict e-cigarette use in order to understand and identify who may be at risk.

Electronic cigarettes, often referred to as e-cigarettes or vapors, are battery-powered devices that deliver a vaporized form of nicotine. In 2004, e-cigarettes were first manufactured and marketed in China by the Beijing company, Ruyan (Dawkins, Turner, Roberts, & Soar, 2013; Dockrell, Morrison, Bauld, & McNeill, 2013). By 2007, e-cigarettes were introduced to the U.S. market. Since then, there has been an explosion in e-cigarette production and widespread marketing. By early 2014, there were 466 brands on the market, advertising via their own company websites and offering their own unique flavors and product designs (Zhu et al., 2014). Products are sold primarily via the Internet, but can also be found in smoke shops and in mall kiosks. A recent study found

that 54.4% operate exclusively online, and 70.2% use more than one social network service to market their product (Mackey, Miner, & Cuomo, 2015). A wide variety of flavors are offered, including watermelon, chocolate, and mint.

E-cigarettes also come in a variety of designs where they can either be recharged or discarded after one use. Although designs vary depending on the manufacturer, most e-cigarettes are composed of a battery, a cartridge, an atomizer, an airflow sensor, and a light bulb at the end of the e-cigarette. Cartridges are available in a variety of nicotine concentrations, and are replaced when the cartridge is finished. The cartridge also contains the user's choice of flavoring in the form of liquid called e-liquid. During inhalation, the airflow sensor activates the battery, which then causes the atomizer to heat and vaporize the nicotine contained in the cartridge. The vaporized nicotine is then inhaled and the light bulb is lit, which is an indication that the e-cigarette is in use.

Although ongoing regulatory debate over the safety of e-cigarettes continues to take place, various manufacturers have made claims that e-cigarettes are completely safe and void of secondhand effects. In 2014, 59 e-cigarette brands were investigated, for which 95% of the manufacturers claimed that e-cigarettes were healthier and cleaner than conventional cigarettes (Grana & Ling, 2014). Furthermore, for the majority of the brands investigated, manufacturers also claimed they were cheaper than cigarettes (93%), their products could be used in areas where smoke-free policies were enforced (71%), and utilization would not result in secondhand smoke effects (76%) (Grana & Ling, 2014). Manufacturers' safety claims have been widely disputed as a result of increased evidence that refutes them. For example, researchers have found that during e-cigarette use, the vapors that are released may contain unsafe metals, volatile organic compounds

(VOCs), and other toxic particles (Goniewicz, Knysak, et al., 2013; Goniewicz, Kuma, et al., 2013; Williams et al., 2013). In some brands, the amount of toxins released during use is found to be higher than what is ultimately released by conventional cigarettes (Williams et al., 2013). Recent research also suggests that e-cigarettes contain the form of nicotine that is just as addictive as the form found in conventional cigarettes (American Chemical Society, 2015). Similar to what is observed with prolonged tobacco smoking, five minutes of e-cigarette use has also been found to lead to immediate harmful physiological effects, such as respiratory impedance and flow respiratory resistance (Vardavas et al., 2012). In addition, in an online survey given in ten different languages to more than 19,000 participants, 57.9% reported the presence of at least one unfavorable health symptom after using e-cigarettes (Farsalinos et al., 2014), with the most frequently reported negative health symptom endorsed being sore or dry mouth and throat (38.9%).

In May 2016, the Food and Drug Administration (FDA) was granted regulatory jurisdiction over all tobacco products, which included e-cigarettes. This rule means that, at the federal level, the manufacturing practices of the producers of e-cigarettes, which includes labeling, packaging, advertising, and sales, are now regulated by the FDA. Prior to this recent ruling, manufacturing practices were not regulated and manufacturing companies were not mandated to follow certain standards for quality control in the design, labeling, or production of e-cigarettes (Trtchounian & Talbot, 2011). Poor design quality and defects in the materials used could lead to catastrophes known as thermal runaway where consumers could be using an e-cigarette that is at risk of exploding while charging or in use (Wang et al., 2012). Labeling practices were also not regulated. In a study investigating the nicotine content of the 30 most popular e-cigarette brands in the

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U.S. and European markets, Goniewicz et al. (2013) found that nine out of the 20 e-cigarette cartridges investigated had labels that indicated different nicotine levels than what was actually the case (Goniewicz et al., 2013). Several of these cartridges had nicotine levels that differed by more than 20% from what was labeled by their manufacturers. In a similar study, Cameron and colleagues also found that manufacturers had mislabeled their products with incorrect nicotine levels (Cameron et al., 2014). These findings suggest that the absence of regulation posed a potential threat leading to unintentional and unsafe practices due to poor product design and incorrect content labeling. Although the FDA is now recently imposing its jurisdiction over the manufacturing practices of e-cigarettes, changes to these problematic manufacturing practices are just in the beginning stages, as manufacturers begin to submit their products for review. Therefore, the use of e-cigarettes should still be viewed with caution. Adolescents may be particularly at risk, because unsafe behaviors that could lead to morbidity and mortality, including smoking, tend to ensue during this age period (Eaton et al., 2012).

Researchers have found lasting harmful effects of nicotine use on the developing adolescent brain (Dwyer, McQuown, & Leslie, 2009). In a study in which rats were administered levels of nicotine typically seen in adolescent smokers, these rats exhibited disturbances in brain cell development and synaptic activity, which persisted for more than a month post nicotine administration (Slotkin, 2002). Additionally, these nicotine-induced brain abnormalities were unique to just the adolescent brain and were not observed in the adult brain (Slotkin, 2002). Other researchers have found that nicotine exposure may cause irregular changes in white matter microstructure in the developing

adolescent brain (Ewijk et al., 2015). In another study, adolescent mice exposed to low nicotine levels and mice exposed to high nicotine levels both experienced significantly increased novelty-seeking and anxiety-like behaviors during and after nicotine exposure (Abreu-Villaça et al., 2015). Taken together, these findings suggest that adolescents comprise an age group that is particularly vulnerable to the harmful effects of nicotine exposure. It is critical to focus efforts toward testing whether certain characteristics predict early adolescent e-cigarette use and use this information to inform policymakers and further improve designs of prevention programs.

In light of the questionable safety of e-cigarettes and the potentially harmful effects of nicotine on the adolescent brain, it is important that adolescents are fully informed about the claims e-cigarette advertisements tend to make to prevent any misrepresentation. Misinformed beliefs regarding the safety of e-cigarettes may play an important role in e-cigarette use initiation. In a Polish high school sample of 11,893 participants aged 15 to 19 years, more than half (54.8%) reported that they believed e-cigarettes were a safer alternative to tobacco products (Goniewicz & Zielinska-Danch, 2012). Research regarding adolescents' beliefs about the safety of e-cigarettes is quite limited, but several researchers have examined young adults' beliefs about the safety of e-cigarette and can provide insight regarding adolescents' beliefs. For example, Sutfin et al. (2013), found that 23% of college students in a U.S. sample believed e-cigarettes were less harmful than conventional cigarettes. The possible appeal of e-cigarettes and the tendency to believe that they are safer products to use compared to conventional cigarettes may make adolescents more likely to use e-cigarettes, thus placing them at increased risk for the harmful neurological effects caused by nicotine use.

Although e-cigarettes have recently been banned from being sold to minors nationwide effective August of 2016 (FD&C Act, 2016), e-cigarettes are predominantly sold online where it may be difficult to regulate sales to minors, and in shopping mall centers where adolescents may spend considerable time, potentially providing the opportunity for adolescents to become attracted to their appeal. For example, public health authorities believe that currently available youth-friendly e-cigarette flavors will attract and introduce young users to nicotine (Kong et al., 2015; Krishnan-Sarin et al., 2015; Noel, Rees, & Connolly, 2011). The appeal of flavored e-cigarettes to adolescents may mimic the appeal of flavored conventional cigarettes, which were banned in 2009 (except menthol) in an attempt to protect and prevent adolescents from experimenting with tobacco and becoming vulnerable to nicotine dependency. Despite this ban, the appeal of varied flavored options in tobacco products continues to remain an issue for the prevention of nicotine use among adolescents. High school smokers are three times more likely to use flavored cigarettes than their adult counterparts (Klein et al., 2008; U.S. Department of Health and Human Services, 2012). These findings suggest that offering conventional cigarettes that come in a variety of flavors to adolescents is a marketing strategy that is particularly effective. In combination with manufacturers' claims of safety and the variety of flavored choices for e-cigarettes may be just as appealing as offering flavored options for conventional cigarettes.

Some advocates of public health express concern that e-cigarettes may introduce nicotine to individuals who have otherwise never been exposed to nicotine prior to e-cigarettes. In a 2012 survey, researchers found that middle school students comprised the highest number of e-cigarette users who had never previously smoked tobacco (Corey et

al., 2013). In fact, 20.3% of these students reported past and 38.9% reported current e-cigarette use while also reporting being non-tobacco users (Corey et al., 2013). Among another sample of middle school students who reported e-cigarette use experience, 51.2% reported that they had never tried any tobacco products prior to using e-cigarettes (Krishnan-Sarin et al., 2015). These proportions of middle school adolescents are much higher than the proportion of adults from a different study who reported being lifetime e-cigarette users while having never smoked conventional cigarettes (Sutfin et al., 2013). Among a sample of adult college students, only 12% had tried e-cigarettes but had never smoked conventional cigarettes (Sutfin et al., 2013).

Several studies have also examined rates of e-cigarette use among high school students and found that there is a notable proportion of students who report prior or current e-cigarette use while also reporting no prior use of conventional cigarettes. For example, Camenga et al. (2014) found that 16.1% of high school current e-cigarette users had never smoked conventional cigarettes (Camenga et al., 2014). Other researchers examined prevalence rates of first-time nicotine users among Polish adolescents aged 15 to 19 years and found that 3.2% reported e-cigarette use but had never smoked a regular cigarette (Goniewicz & Zielinska-Danch, 2012). It appears that e-cigarettes may provide an avenue for the introduction of nicotine use to adolescents as e-cigarettes continue to grow in popularity and appeal among youth. Public health specialists need to consider these implications prior to designing and implementing prevention programs for youth. In doing so, the creators of prevention programs can incorporate specialized interventions that target adolescents who are at risk for being first time nicotine users through the use of e-cigarettes.

There has also been emerging evidence that some adolescents who initiate e-cigarette use eventually progress to dual use of both e-cigarettes and conventional cigarettes. Several recent studies have noted this rise in dual use particularly among adolescents. For example, in a survey conducted in 2011 among South Korean adolescents aged 13 to 18 years, 8.0% reported lifetime dual use of both products while 3.6% reported current dual use (Lee, Grana, & Glantz, 2013). In study of high school students from Hawaii, researchers found that 12% had reported that they were current dual users of both e-cigarettes and conventional cigarettes (Wills et al., 2014). Similarly, Primack et al. (2015) found that 37.5% of adolescents and young adults who reported e-cigarette use at baseline eventually proceeded to smoking conventional cigarettes as well. Together, these findings give rise to the question of whether there has been a renormalization of nicotine use particularly among adolescents (Fairchild, Bayer, and Colgrove, 2014). In addition, the fact that e-cigarette use may serve as a mechanism by which adolescents are introduced to nicotine and then progress to traditional cigarette use (and its associated negative health consequences) highlights the need to improve prevention effects by determining what factors predict e-cigarette use among adolescents.

Research regarding factors that influence adolescent e-cigarette use is in its beginning stages. Therefore, when investigating possible predictors of adolescent e-cigarette use, it may be useful to first examine known predictors of conventional cigarette use and determine whether they may also predict e-cigarette use. For example, attitudes toward a behavior generally are significant predictors of that behavior (Ajzen & Fishbein, 1977), and this applies to smoking behavior (Joffer et al., 2014; Rise, Kovac, Kraft, & Moan, 2008). Previous research suggests that negative attitudes toward cigarette-related

factors, such as nicotine addiction, may be a protective factor against smoking, whereas more positive attitudes tend to be a risk factor. For example, children who believe that addiction can result immediately after initiating cigarette smoking are more committed to remaining smoke free, whereas those who believe addiction only happens after smoking several cigarettes report intentions to initiate smoking in the near future (Wang, Henley, & Donovan, 2004). However, there is evidence suggesting that adolescents may not completely understand the risks and nature of tobacco addiction (Halpern-Felsher et al., 2007). In line with these findings, Amos et al. (2006) found that most adolescent smokers are uncertain about whether or not they are addicted and that only a small group of participants recognize that they are addicted to cigarettes.

There is evidence to suggest that for some adolescents, nicotine addiction may be perceived positively. For example, in a study of youths reporting a variety of smoking histories, some reported pretending to be addicted to nicotine in order to portray an image that is perceived as more appealing (Bottorff et al., 2004). In a review of 19 studies on adolescents' perceptions toward nicotine dependence, adolescent smokers tended to balance their negative perceptions of nicotine addiction with the satisfying features of smoking (Walsh & Tzelepis, 2007). For example, adolescent smokers reported positive opinions toward having cravings for what they perceived to be an appealing substance.

Previous research has also indicated that adolescents tend to underestimate their own risk of harm that results from cigarette smoking (Sheppard, Klein, Waters, & Weinstein, 2013). Although nicotine addiction is recognized by youth as a negative consequence to smoking, the majority report that their susceptibility to nicotine addiction is not personally relevant, especially for younger adolescents and those who have just

begun smoking (Walsh & Tzelepis, 2007). These researchers also noted that adolescents'

attitudes toward cigarette addiction were associated with current smoking status, such

that smoking adolescents tended to perceive less personal susceptibility to nicotine

addiction, even though studies show that adolescents who initiate smoking are at

considerable risk for problems with addiction. For example, in a study investigating

factors related to nicotine dependence in 6th grade students, researchers reported that

smoking adolescents found quitting to be difficult within just one to two days of initiating

smoking (DiFranza et al., 2007). These findings suggest that adolescents who

underestimate their risk of addiction are more likely to smoke, and those who already

smoke further underestimate their risk for addiction.

Nonsmoking adolescents' intentions to smoke may be influenced by personal

perceptions of addiction. Two recent studies indicate that nonsmoking adolescents are

much more likely to recognize the risk of addiction associated with smoking traditional

cigarettes (Aryal, 2013; Dhungel & Bhandari, 2015). When combined with the tendency

to believe that e-cigarettes are safer than conventional cigarettes (Ambrose et al., 2014,

Anand et al., 2015), adolescents who express greater concerns about addiction to

traditional cigarettes may consider e-cigarettes as a less risky alternative, but further

research is needed to test this possible association. It is important to assess whether

adolescents, especially those who would not otherwise be at-risk for cigarette smoking,

are more likely to use e-cigarettes as an ostensibly less harmful and less addictive

alternative.

Results from previous studies suggest that perceptions of the risks and negative

consequences of cigarette use may be among the most influential predictors of adolescent

cigarette smoking (Halpern-Felsher, Ramos, & Cornell, 2007; Rodriguez, Romer, & Audrain-McGovern, 2007; Song et al., 2009). Similarly, researchers have found that positive alcohol expectancies are associated with higher levels of drinking among children (e.g., Dunn & Goldman, 2000). These findings suggest that perceptions play a particularly important role in substance use among adolescents. Thus, understanding what individuals tend to perceive as the risks and negative consequences associated with cigarette smoking may be useful in assessing which factors predict e-cigarette use. Perceived risks of cigarette smoking are what individuals believe are likely to happen to them personally in the future as a result of smoking cigarettes, while perceived negative consequences are those that individuals generally see as being associated with smoking cigarettes.

While as many as 86% of adolescents recognize the general risks involved in cigarette smoking (Aryal, 2013; Roditis & Halpern-Felsher, 2015), many continue to misjudge their personal risk primarily due to underestimating the severity of tobacco-related diseases, or because they believe they are less susceptible to those risks compared to their peers (Romer & Jamieson, 2001; Sheppard, Klein, Waters, & Weinstein, 2013). In turn, lower perceived risk of harm from cigarette smoking predicts smoking initiation among youth (Doest, Dikstra, Gebhardt, & Vitale, 2009; Smith, Bean, Mitchell, Speizer, & Fries, 2007; Song et al., 2009). Previous research shows that smokers tend to perceive fewer negative health consequences of smoking than nonsmokers, which substantiates previous findings indicating that individuals who perceive fewer negative consequences associated with smoking are more likely to initiate smoking (O'Connor et al., 2007; Sherman, Chassin, Presson, Seo, & Macy, 2009). For example, among a sample of

adolescent girls, 59% of daily smokers were significantly more likely to believe that smoking did not have harmful health consequences compared to occasional smokers and nonsmokers (Nichter et al., 1997). These findings suggest that adolescents are generally aware of the risks associated with cigarette smoking, but those who underestimate their own personal risk or believe that fewer negative consequences are associated with smoking in general are more likely to initiate cigarette smoking. It is possible that adolescents who recognize their own personal susceptibility to the risks associated with cigarette smoking may turn to e-cigarettes instead, but this hypothesis has not yet been tested.

While there is evidence that the majority of today's adolescents are well aware of the consequences of smoking traditional cigarettes (Aryal, 2013; Roditis & Halpern-Felsher, 2015; Song et al., 2009), they are more likely to have less knowledge or to have received inaccurate information regarding the risks of e-cigarette use, which researchers are concerned may lead to positive or ambivalent perceptions of e-cigarettes (Roditis & Halpern-Felsher, 2015). In one study, participants reported that cigarettes were harmful and embarrassing to use, while e-cigarettes were classy and did not contain nicotine, but they were unsure about the consequences of e-cigarette use (Roditis & Halpern-Felsher, 2015). Thus, it is possible that adolescents who perceive more negative consequences of cigarette smoking may turn to e-cigarettes as an alternative that they believe has fewer negative consequences. However, research assessing the relationship between perceptions of the risks and negative consequences of cigarette smoking and e-cigarette use among adolescents has yet to be conducted.

Perceived benefits of cigarette smoking may also play an important role when examining possible predictors of adolescent e-cigarette use. Previous research suggests that when perceived benefits outweigh perceived risks associated with cigarette smoking, there is a greater likelihood for engaging in cigarette smoking among adolescents. For example, in a study of college youth and their perceptions of cigarette smoking, the majority of participants who were smokers reported that the benefits of smoking were greater than the risks (Wolburg, 2006). In line with these findings, Song et al. (2009) observed that the odds of smoking initiation were 3.64 and 2.68 times greater for adolescents who believed the long- and short-term risks associated with cigarette smoking were least likely to occur compared to those who did not endorse these beliefs. Similarly, in a study of Chinese adolescents, the perception of positive psychological and social benefits from smoking at baseline was associated with cigarette smoking during follow-up (Chen et al., 2006). Additionally, researchers have found evidence to suggest that perceived invulnerability to physical danger predicts smoking behavior by increasing the perceived benefits of smoking (Morrell, Lapsley, & Halpern-Felsher, 2015).

These findings emphasize the influence of perceptions of the benefits of smoking on smoking behaviors. Therefore, it is important to investigate whether a relationship exists between perceived benefits of cigarette smoking and e-cigarette use among adolescents so that researchers can better predict adolescents who are at-risk for e-cigarette use initiation. This is especially important in circumstances where adolescents perceive cigarette smoking as beneficial but also too risky and receive messages in the media that e-cigarettes pose the same level of benefits associated with conventional cigarettes, but with fewer risks. Adolescents who perceive fewer social and emotional

benefits and more long-term and short-term risks associated with cigarette smoking may choose to use e-cigarettes instead, especially if they believe that e-cigarettes are a safer alternative for conventional cigarettes.

In efforts to prevent further initiation of smoking, antismoking advertisements targeting adolescents have been used to inform adolescents about the dangers of smoking (Emory et al., 2015, Yu et al., 2015). Previous studies indicate that adolescents are more receptive to nicotine and tobacco-related advertisements than are adults (Pollay et al., 1996). These findings suggest that antismoking ads may be useful in decreasing intentions to smoke among adolescents. In support of this, studies show that anti-smoking ads are effective in decreasing intentions to smoke or reducing further smoking among adolescents who have already initiated (Andrews, Netemeyer, Burton, Moberg, & Christiansen, 2004; Pechmann, Zhao, Goldberg, & Reibling, 2003; Siegal & Biener, 2000). Results from a school-based study found that information about the short-term effects of smoking on physical appearance (e.g. yellow teeth) and fitness significantly affected students' beliefs about smoking (Michaelidou, Dibb, & Ali, 2008). These observations suggest that increased exposure to information about the negative consequences of smoking may lead to decreased intentions to smoke cigarettes. However, adolescents who have decreased intentions to smoke cigarettes through increased exposure to antismoking information may seek alternative methods, such as e-cigarettes, that may be perceived as safer. Further research is needed to test the extent of this relationship.

The overarching goal of the current study is to examine the relationship between perceptions of the risks, benefits, and consequences of conventional cigarettes, attitudes

about addiction to conventional cigarettes, exposure to information about the dangers of conventional cigarettes and e-cigarette use among adolescents after controlling for number of friends who smoke cigarettes and having previous cigarette smoking experience. We hypothesize that negative attitudes toward addiction to conventional cigarettes, greater perceptions of risks and perceived benefits of cigarettes, more negative perceptions of the consequences of cigarette smoking, and increased exposure to information about the dangers of smoking will predict increased adolescent e-cigarette use. We will control for the effects of cigarette smoking experience and having friends who smoke if both variables are screened and found to be significant predictors of e-cigarette use. These covariates are consistent with prior research indicating that they are significant predictors of e-cigarette use among adolescents (Anand et al., 2015; Goniewicz & Zielinska-Danch, 2012; Hanewinkel & Isensee, 2015; Krishnan-Sarin et al., 2015).

CHAPTER TWO

METHODS

Participants

One hundred eighty students in grades six through nine were recruited from one California middle school and one California high school (see Table 1). Participants reported answers to a series of questions related to a variety of demographic factors including current grade level, sex, ethnicity/race, and age. Participants were between the ages of 13 and 15 years ($M = 13.23$, $SD = 0.89$). Regarding gender, 60.0% identified as female, 38.9% identified as male, and the remaining participants did not disclose their gender. The majority of the sample identified as Mixed Race (31.3%) when asked to report their racial identity, followed by Latino (29.4%), Asian/Asian American (15.6%), White (9.4%), Other (2.8%), Black (2.5%), Native Hawaiian/Other Pacific Islander (2.5%), and American Indian/Alaska Native (1.9%). Those who reported being in ESL and/or special education courses were excluded from the final analyses.

Table 1. Demographic Information and Measured Characteristics of Sample.

Characteristic	N (%)	M (SD)
Race		
Latino	52 (29.38%)	
American Indian/Alaska Native	3 (1.70%)	
Asian/Asian American	25 (14.10%)	
Native Hawaiian/Pacific Islander	4 (2.30%)	
Black/African American	4 (2.30%)	
White	15 (8.50%)	
Mixed Race	50 (28.20%)	
Other	5 (2.82%)	
Ethnicity		
Hispanic or Latino	120 (67.80%)	
Not Hispanic or Latino	54 (30.50%)	
Sex		
Female	107 (60.50%)	
Male	68 (38.40%)	
Previous Cigarette Smoking Experience	17 (9.60%)	
Lifetime E-cigarette Use	10 (5.60%)	
Age		13.22 (0.90)
Attitudes Toward Cigarette Addiction		9.65 (5.82)
Perceptions of Cigarettes		
Perceptions of Long-term Risks		85.12 (20.77)
Perceptions of Short-term Risks		80.40 (21.94)
Perceptions of Benefits		23.10 (23.02)
Perceptions of Consequences of Cigarette Smoking		
Social Facilitation		34.61 (5.21)
Negative Physical Feelings		10.73 (3.73)
Exposure to Information About Dangers of Smoking		4.21 (1.57)

Materials

Attitudes toward Cigarette Addiction

Attitudes toward cigarette addiction were measured using three questions that were adopted from another survey. These items assessed for the length of time it would take to become addicted to cigarettes and the level of difficulty and effort involved in smoking cessation after hypothetically smoking two to three cigarettes per day. The first question addresses the ease of smoking cessation, which states, "If you smoke about 2 or 3 cigarettes, how easy will it be for you to quit smoking?" The two remaining questions address the length of time it would take to become addicted to cigarettes and to become a regular smoker stating "If you smoke about 2 or 3 cigarettes each day, how long will it take until you become addicted to cigarettes?" and "If you smoke 2 or 3 cigarettes each day, how long will it take until you become a regular smoker?" Responses were based on a five-point Likert scale (1 = *Will Not Happen* to 5 = *3-4 years*; 1 = *Very easy* to 5 = *Not Very Easy*). Reponses to the second and third question were reverse scored and then all three responses were combined for a total score. Higher total scores indicate a more negative attitude toward cigarette addiction. For the present study, a reliability analysis was performed for these three items (α = .52).

Perceptions about the Risks and Benefits of Smoking

Previous researchers who performed a principal components analysis indicated that the perceptions of risks and benefits of smoking can be divided into three components: perceived short-term risks, long-term risks, and benefits of cigarette smoking (Guilamo-Ramos et al., 2007; Song et al, 2009). Therefore, for the present

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study, we categorized the perceived risks and benefits of cigarette smoke into these three groups. Short-term risks included items such as "You will have bad breath" and "You will get into trouble." Long-term risks included items such as "You will get lung cancer" and "You will get wrinkles on your face." Lastly, perceptions of benefits included items such as "You will look cool" and "You will be more popular."

Perceptions about 15 smoking-related risks and benefits of cigarette smoking were measured by providing participants with two imagined smoking scenarios. The first scenario evaluates perceptions of short-term risks and benefits, whereas the second scenario measures perceptions of long-term risks associated with cigarette smoking. For the first scenario, participants were given the following instructions: "Imagine that you just began smoking. You smoke about two or three cigarettes each day. Sometimes you smoke alone, and sometimes you smoke with friends. If you smoke about two or three cigarettes each day, what is the chance that...?" For the second smoking-related scenario, participants were given the following instructions: "Imagine that you continued to smoke about two or three cigarettes each day for the rest of your life. What is the chance that...?" Participants were then instructed to report the likelihood that a specified outcome will occur by recording any number between 0 to 100%. Scores for each corresponding variable were then averaged. Song et al. (2009) and Morrell et al. (2010) included internal consistency reliabilities on this measure for perceptions of short-term risks ($\alpha =$ .80 to .90), perceptions of benefits ($\alpha =$ .71 to .73), and perceptions of long-term risks ($\alpha =$ .88 to .92). For the present study, similar internal consistency reliabilities were found for perceptions of short-term risks ($\alpha =$ .84), long-term risks ($\alpha =$ .87), and benefits ($\alpha =$ .78).

Smoking Consequences

Perceptions associated with the consequences of cigarette smoking were measured using the Adolescent Smoking Consequences Questionnaire (ASCQ; Lewis-Esquerre, Rodrigue, & Kahler, 2005), which is a 30-item measure using a five-point Likert scale (1 = *Never* to 5 = *Always*). The ASCQ has seven subscales: Negative-Affect Reduction, Taste/Sensorimotor Manipulation, Social Facilitation, Weigh Control, Negative Physical Feelings, Boredom Reduction, and Negative Social Impression. Participants were asked to indicate what they believe will occur as a consequence or result of smoking cigarettes. For the present study, we chose to use the Social Facilitation and Negative Physical Feelings subscales in the final analysis, because these subscales had the highest reliabilities (α = .78 and .80, respectively) and demonstrated the strongest correlations with the proposed dependent variable, lifetime e-cigarette use (see Table 2). Responses for the Social Facilitation subscale were combined for a total score with higher total scores indicating a greater perception that smoking results in social benefits. Additionally, scores from the Negative Physical Feelings subscale were combined for a total score with higher total scores indicating a greater perception that smoking results in negative consequences.

Exposure to Information about the Dangers of Smoking

One item was used to assess adolescents' exposure to information regarding the dangers of cigarette smoking. This item was taken from a four-item measure developed for a longitudinal study, which was based on items from a previous study on adolescent cigarette smoking (Morrell, Song, & Halpern-Felsher, 2010). Participants were asked

"Have you seen or heard information about the dangers of smoking and why you shouldn't smoke…" after which the question was followed by six examples of media or informational sources such as "on TV" or "on the internet." Participants were given to the options of either "yes," "no," or "don't know." All "yes" responses were combined for a total exposure score. Higher scores indicate more exposure to information about the dangers of smoking.

E-cigarette Use

To measure history of e-cigarette use, participants were asked to report how often they had used e-cigarettes within their lifetime. This item was adapted from a survey assessing adolescent risk behavior (Morrell, Song, & Halpern-Felsher, 2010). The item states, "During your entire life, about how many times have you used an electronic cigarette?" Participants reported a specific estimate of the number of times they had smoked an e-cigarette.

Table 2. Correlations Among Key Variables.

	1	2	3	4	5	6	7	8	9
1. PSE	-								
2. ATA	-.009	-							
3. LTR	-.096	.162	-						
4. STR	-.222**	.245**	.628**	-					
5. BEN	.199*	.232**	-.014	.117	-				
6. SF	-.051	-.180*	-.018	-.005	-.587**	-			
7. NPF	-.034	.333**	.307**	.515**	.106	-.173*	-		
8. DOS	-.121	.191*	.153	.108	-.090	-.017	.077	-	
9. LEU	.676**	-.022	.033	-.104	.261**	-.086	-.031	-.045	-

Note. PSE = previous smoking experience; ATA = attitudes toward addiction; LTR = perceptions of long-term risks; STR = perceptions of short-term risks; BEN = perceptions of benefits; SF = social faciliation subscale; NPF = negative physical feelings subscale; DOS = exposure to information about the dangers of smoking; LEU = lifetime e-cigarette use.
*p < .05. **p < .01.

Procedure

For the present study, we used baseline data collected from a larger randomized control trial of a web-based smoking prevention program called the Adolescent Smoking Prevention Project (ASPP), which was approved by Loma Linda University's Institutional Review Board. During the recruitment and informed consent process, research personnel visited each school and gave brief in-class presentations that provided details regarding the study's purpose, procedures, risks and benefits of participation, compensation plan, and confidentiality assurance. If a child wished to participate, a parental consent form and a child assent form were given. All potential participants were instructed that the consent form provided must be signed and dated by at least one parent or legal guardian in order to participate in the study. Participants who were 12 years old or younger were required to provide a signed assent form while participants 13 years old and older were required to sign a consent form in order to participate. These forms provided an outline of the study and contact information for research personnel for any questions or concerns. Participants were also informed that they could choose to discontinue their involvement with the study at any moment without penalty. Research personnel informed all potential participants that they would then return to the schools the following week to collect the consent and assent forms and administer the study to students who wished and were qualified to participate.

Baseline data were collected in two rounds a week after the initial presentations at the selected study locations by administering an in-class questionnaire, which consisted of 197 questions. The first round of data collection took place at a high school, and the second round was conducted at a middle school. Prior to administering the in-class

questionnaire, research personnel verified that all required consent forms were signed and dated. A separate classroom task was given to all the students who did not provide the signed consent documents or who did not wish to participate. Meanwhile, study personnel provided additional information about the study to confirmed participants, such as details regarding compensation.

All participants were then given a written questionnaire and instructions for how to complete it. Items from the questionnaire addressed multiple topics related to smoking behavior and its correlates, such as friends' smoking behavior, academic performance, attitudes toward addiction, and perceived short-term and long-term risks of cigarette smoking. Upon completion, research personnel collected the consent/assent forms and questionnaires and provided each participant with a piece of candy of his or her choice for completing the baseline portion of the study.

Statistical Analysis

A hierarchical multiple linear regression analysis was used to test attitudes toward cigarette addiction, perceptions about the risks and benefits of cigarette smoking, perceptions of the consequences of cigarette smoking, and exposure to information about the dangers of smoking as predictors of adolescent e-cigarette use. All analyses were performed using SPSS version 20. The data were checked for outliers and violations of assumptions of multiple linear regression. Outliers were determined by examining cases that have high leverage values, discrepancy, and influence (Cohen, Cohen, West, & Aiken, 2003). Two cases were determined to be outliers and were removed. The assumption of normality of residuals was violated. Attempts to remedy the violation were

made by conducting square root, natural log, and inverse transformations of the dependent variable. Next, all assumptions of multiple linear regression were retested, but the assumption of normality of residuals continued to be violated. Therefore, it was determined that conducting a hierarchical binomial logistic regression analysis predicting any e-cigarette use (0 = no and 1 = yes) was the most appropriate next step.

The data were subsequently analyzed for outliers as well as violations of assumptions of binomial logistic regression. Outliers were defined as cases with a standardized residual that was greater than the absolute value of three. One case was determined to be an outlier and was removed from the analysis. The assumption of linearity in the logit was violated for the number of friends who smoke cigarettes variable. Number of friends who smoke cigarettes was transformed using the square root, natural log, and inverse methods. Subsequently, all assumptions were re-tested, but the violation continued to persist. Therefore, number of friends who smoke cigarettes was excluded from the final analysis.

Having cigarette smoking experience is a dichotomous covariate that was entered into the first step of the logistic regression analysis in order to control for its effects. Attitudes toward cigarette addiction is a continuous variable that was entered into the model in the second step. Perceptions of cigarettes, which was separated into three continuous variables (perceptions of smoking-related short-term risks, long-term risks, and benefits), was entered into the model next. In the fourth step, social facilitation and negative physical feelings, which are two continuous predictor variables representing perceived smoking consequences, was entered into the analysis. Lastly, exposure to information about the dangers of smoking, a continuous predictor variable, was entered

into the model. Adding exposure to information of the dangers of smoking in step 5 of the analysis resulted in unusually large regression coefficients, standard errors, and odds ratios, suggesting there were not enough cases to analyze that many variables. Therefore, exposure to the dangers of smoking was excluded and only findings from step 4 of the analysis are reported here. To account for the possible effects of exposure to information about the dangers of smoking, a second analysis was conducted where exposure to information about the dangers of smoking was added while attitudes toward cigarette addiction was excluded.

A post hoc power analysis was performed because archival data were used. With a sample size of 177 participants and eight predictor variables, the power analysis indicated that the study had approximately 90.8% power to detect a clinically significant effect of $OR = 2.0$ at $\alpha = 0.05$ (see Table 1). Furthermore, the study had approximately 99.9% power to detect either a truly significant moderate effect of $OR = 3.0$ or a large effect of $OR = 4.0$ (Ferguson, 2009).

CHAPTER THREE

RESULTS

A hierarchical logistic regression analysis was used to assess the odds of being a lifetime e-cigarette user based upon an individual's attitude toward cigarette addiction, perceptions toward cigarettes, and perceptions of the consequences of cigarette smoking after controlling the effect of previous cigarette smoking experience (see Table 3). The covariate, previous cigarette smoking experience, had a significant effect on the odds of being a lifetime e-cigarette user, $p < .01$. The odds of being a lifetime e-cigarette user were 100% greater for those with previous cigarette smoking experience than for those without previous cigarette smoking experience ($OR = .000$, 95% CI [.000, .054], $p < .01$). Attitudes toward cigarette addiction and perceptions about the consequences of cigarette smoking did not have significant effects on the odds of being a lifetime e-cigarette user, ps $> .1$. Additionally, perceptions of the short-term and long-term risks of smoking cigarettes did not have significant effects on the odds of being a lifetime e-cigarette user, ps $> .2$. However, perceptions of the benefits of cigarette smoking had a significant effect on the odds of being a lifetime e-cigarette user, $p < .05$. For every one-unit increase in the perceived benefits of cigarette smoking, the odds of being a lifetime e-cigarette user increased by 14.1% ($OR = 1.141$, 95% CI [1.004, 1.297], $p < .05$).

Table 3. Results of First Logistic Regression Analysis Predicting Odds of Lifetime E-cigarette Use.

	OR	p	95% CI
Previous Smoking Experience	.000	< .01	[.000, .054]
Attutides Toward Cigarette Addiction	.844	> .3	[.597, 1.191]
Perceptions of Long-Term Risks	1.060	> .2	[.966, 1.162]
Perceptins of Short-Term Risk	.962	> .5	[.854, 1.085]
Perceptions of Benefits	1.141	< .05	[1.004, 1.297]
Social Faciliation	1.184	> .4	[.758, 1.848]
Negative Physical Feelings	1.524	> .1	[.853, 2.725]

In order to ensure that exposure to the dangers of smoking was accounted for, a second hierarchical logical regression was conducted (see Table 4). Attitudes toward cigarettes was excluded in this second analysis so that exposure to the dangers of smoking could be added without resulting in large regression coefficients, standard errors, and odds ratios due to insufficient number of cases. Attitudes toward cigarettes was excluded from this model because this variable did not significantly predict the odds of being a lifetime e-cigarette user in the previously described model. Variables representing risk perceptions and consequences of smoking were kept in the model because two to three variables represented each construct, and it would not be logically consistent to exclude one variable but not the others. Therefore, it was concluded that attitudes toward cigarettes was the most reasonable variable to exclude from the second analysis while also minimizing any unnecessary changes from the previous model.

Table 4. Results of Second Logistic Regression Analysis Predicting Odds of Lifetime E-cigarette Use.

	OR	*p*	95% CI
Previous Smoking Experience	.000	< .05	[.000, .893]
Perceptions of Long-Term Risks	1.220	> .3	[.793, 1.879]
Perceptins of Short-Term Risk	1.010	> .9	[.849, 1.202]
Perceptions of Benefits	1.378	> .09	[.940, 2.020]
Social Faciliation	1.359	> .3	[.699, 2.642]
Negative Physical Feelings	2.550	> .08	[.853, 7.618]
Exposure to Information About Dangers of Smoking	.185	> .05	[.031, 1.090]

In this second analysis, previous cigarette smoking experience was added in the first step of the analysis. In the second step of the analysis, perceptions of the long-term risks, short-term risks, and benefits of cigarette smoking were added into the model. In the third step of the analysis, perceptions of social facilitation and negative physical feelings were added into the model. Lastly, exposure to the dangers of cigarette smoking was added in the fourth step of the analysis. Previous cigarette smoking experience still significantly predicted the odds of being a lifetime e-cigarette user, $p < .05$. The odds of being a lifetime e-cigarette user were 100% greater for those with previous cigarette smoking experience than for those without cigarette smoking experience ($OR = .000$, 95% CI [.000, .893], $p < .05$). Perceptions of the short-term risks, long-term risks, and consequences of smoking cigarettes did not have significant effects on the odds of being a lifetime e-cigarette user, ps $> .09$. Furthermore, in contrast to the previous model, perceptions of the benefits of cigarette smoking was no longer a significant predictor of the odds of being a lifetime e-cigarette user, $p > .09$. Exposure to the dangers of smoking also did not have a significant effect on the odds of being a lifetime e-cigarette user, $p > .05$.

CHAPTER FOUR

DISCUSSION

To our knowledge, this study may be the first to examine known predictors of conventional cigarette smoking among adolescents to determine whether these variables may also predict e-cigarette use among adolescents. Previous cigarette smoking experience was associated with increased odds of being a lifetime e-cigarette user, which is consistent with previous research indicating a strong positive association between traditional cigarette smoking and e-cigarette use (Anand et al., 2015). Similarly, Krishnan-Sarin et al. (2015) found that lifetime cigarette smokers and current cigarette smokers had significantly greater odds of being a lifetime e-cigarette user than adolescents without cigarette smoking experience ($OR = 13.04$ and $OR = 65.11$, respectively). These findings suggest that adolescents with a history of conventional cigarette smoking experience are at particular risk for e-cigarette use. Given the association between conventional cigarette smoking and e-cigarette use among adolescents, members of the tobacco control community are concerned that adolescents who use e-cigarettes are also smoking traditional cigarettes simultaneously. In a recent study, Primack et al. (2015) found that 37.5% of adolescents and young adults who reported e-cigarette use at baseline eventually progressed to smoking conventional cigarettes concurrently. The question of whether e-cigarettes have contributed to a renormalization of tobacco use, particularly among youth, is another cause for concern adding to the need for improvements in prevention efforts.

Contrary to our predictions, attitudes toward cigarette addiction, perceptions of the long-term risks and short-term risks of cigarettes, perceptions of the consequences of

smoking cigarettes, and exposure to information about the dangers of cigarette smoking were not associated with the odds of being a lifetime e-cigarette user, ps > .05. These results suggest that some perceptions and attitudes, particularly those associated with the negative aspects of cigarette use, may not be related to an adolescent's odds of having ever used an e-cigarette. It may be possible that adolescents do not consider the risks associated with cigarette smoking when deciding whether or not to use an e-cigarette because of the tendency to believe that e-cigarettes are much safer than conventional cigarettes. Perhaps, to many adolescents, the risks associated with conventional cigarette smoking are completely unrelated to the potential risks involved in e-cigarette use. It is possible, however, that these attitudes may predict the number of times an adolescent has used e-cigarettes (e.g., having used an e-cigarette once or a few times versus using an e-cigarette regularly and frequently). However, due to the violations of assumptions of multiple linear regression, the frequency of e-cigarette use could not be tested.

Perceptions of positive aspects of conventional cigarette use, such as the perceived benefits of smoking traditional cigarettes, appear to have a stronger association with the odds of having ever used an e-cigarette than perceptions of the negative aspects of cigarette use. In the first analysis, perceptions of the benefits of cigarettes were significantly associated with the odds of being a lifetime e-cigarette user. These findings suggest that adolescents who perceive greater benefits from conventional cigarette use are at greater odds of using an e-cigarette. After removing attitudes toward cigarettes and adding exposure to the dangers of cigarette smoking into the second analysis, perceptions of the benefits of cigarettes was no longer significantly associated with being a lifetime e-cigarette user. Despite the lack of statistical significance, the odds ratio suggested

potential clinical significance: for each percentage point increase in perceived benefits, the odds of having ever tried an e-cigarette increased by 37.8%. It appears that greater perceptions of benefits of traditional cigarettes (i.e., endorsing beliefs that cigarette smoking is associated with feeling relaxed, being more popular, etc.) are associated with having ever used an e-cigarette, particularly among adolescents, perhaps because adolescents may be looking for an alternative method for receiving such benefits. Adolescents may view using e-cigarettes as a way to obtain the benefits of traditional cigarette use, but without the harmful effects associated with it.

It is also important to note that exposure to information about the dangers of smoking and attitudes toward addiction were significantly correlated in the present study, such that greater exposure to information about the dangers of smoking is associated with more negative attitudes toward addiction. The significant correlation between these two variables may explain why the effect of perceived benefits on e-cigarette use was no longer significant when exposure to information about the dangers of smoking was taken into consideration (see Table 2). The negative attitudes toward addiction that are associated with greater exposure to information about the dangers of smoking may outweigh the effect of perceived benefits of smoking on e-cigarette use.

In terms of effect size, the effect of negative physical feelings on the odds of being a lifetime e-cigarette user in the second analysis was large enough to be considered a clinically significant effect even though it was not statistically significant (Ferguson, 2009). For every one-unit increase on the negative physical feelings subscale, the odds of being a lifetime e-cigarette user increased by 155% ($OR = 2.550$). Furthermore, it is important to note the effect size of exposure to information about the dangers of smoking.

For every additional modality in which an adolescent was exposed to information about the dangers of smoking, the odds of being a lifetime e-cigarette user decreased by 81.5% (*OR* = .185). Perceptions of social facilitation also had an effect size that warrants further consideration. For every one-unit increase on the social facilitation subscale, the odds of being a lifetime e-cigarette user increased by 35.9% (*OR* = 1.359). These findings suggest that although perceptions of negative physical feelings, perceptions of social facilitation, and exposure to information regarding the dangers of cigarette smoking were not statistically significant predictors of having ever used an e-cigarette, these variables may have clinical significance and should be examined in future research.

It is possible that believing cigarette smoking will result in negative physical feelings may increase the chances for an adolescent to use e-cigarettes instead. The Negative Physical Feelings subscale of the ASCQ measures the degree to which participants believe cigarettes will burn a person's throat, make a person's lungs hurt, and make a person cough (Lewis-Esquerre et al., 2005). Adolescents may be more likely to smoke an e-cigarette if they believe that they will not experience these negative physical feelings when smoking an e-cigarette because they are not actually inhaling smoke that comes from burning tobacco. Furthermore, an adolescent who has been repeatedly exposed to anti-cigarette smoking information from a wider variety of sources (e.g., T.V., in the classroom, etc.) may be more likely to use an e-cigarette. It is possible that the misconception that e-cigarettes are safer than conventional cigarettes influences an adolescent's decision to try e-cigarettes in place of conventional ones. Lastly, it is also possible that believing that cigarette smoking will result in social benefits may increase the chances for an adolescent to use an e-cigarette. Adolescents who believe that cigarette

smoking will result in social benefits may be more likely to use e-cigarettes because they may also believe that using them will result in the same social benefits associated with smoking regular cigarettes, but without the health consequences. This explanation is also consistent with the finding in the current study that the perceived benefits of smoking traditional cigarettes were associated with greater odds of having ever tried an e-cigarette, especially given that three of the four perceived benefits that participants rated were social benefits (i.e., looking cool, being more popular, and looking more grown up).

In terms of prevention, efforts should be made to target adolescents with a history of conventional cigarette smoking, because they may be at an increased risk for future e-cigarette use. Recently, researchers have revealed evidence that suggests e-cigarettes may not be as safe as manufacturers have previously claimed. For example, using electron paramagnetic resonance spectroscopy (EPR) to test puffs released during e-cigarette use, researchers found excessive levels of highly reactive free radicals in the aerosols of both e-cigarettes and e-liquids (Goel et al., 2015). Free radicals are toxic molecules associated with smoking-related cancers, chronic obstructive pulmonary disease, and cardiovascular disease, and are considered the leading cause of oxidative stress from conventional cigarette smoking (Penn State Milton S. Hershey Medical Center, 2015). Similarly, another group of researchers found that e-cigarette aerosols and flavorings emit free radicals that cause inflammation and cell damage within the lungs of users (Lerner et al., 2015). In light of this evidence demonstrating the potentially dangerous consequences of e-cigarette use, the prevention of e-cigarette use should be prioritized, particularly among individuals belonging to an age group that some believe are being targeted by manufacturing companies (Kong et al., 2015; Krishnan-Sarin et al., 2015; Noel, Rees, &

Connolly, 2011) and have a known high susceptibility for engaging in risky behaviors (Arnett, 1992; Moffitt, 1933). Furthermore, adolescent e-cigarette use has tripled in one year alone, and e-cigarettes have now surpassed traditional cigarettes as the most commonly used tobacco product in the U.S. (CDC, 2015).

In moving forward with goals for prevention, targeting adolescents who tend to perceive greater benefits from cigarette smoking may be particularly advantageous. It may also be beneficial to provide at-risk adolescents with information highlighting the negative consequences of e-cigarette use, particularly for adolescents who perceive traditional cigarettes as beneficial. Results suggest that greater perceived benefits of conventional cigarettes predicted greater odds of having ever tried an e-cigarette. Therefore, counteracting the effects of perceived benefits of traditional cigarettes should be made a priority. However, when exposure to information about the dangers of conventional cigarettes was taken into account, perceptions of benefits no longer had a significant effect on the odds of being an e-cigarette user. This suggests that knowledge of the dangers of cigarette smoking may serve as a protective factor against e-cigarette use, particularly among adolescents who may perceive conventional cigarette smoking as beneficial. Beliefs about the specific negative physical consequences of traditional cigarette smoking (i.e., throat pain, lung pain, and cough) did not serve as a protective factor against e-cigarette use, but was rather a predictor of having used an e-cigarette. Adolescents may need to be taught that e-cigarettes are in fact associated with similar negative physical consequences as traditional cigarettes, such as throat and mouth irritation (Callahan-Lyon, 2014; Farsalinos et al., 2014; Polosa, Caponettto, Morjaria, Papale, Campagna, & Russo, 2011).

Policies that have been effectively implemented in response to traditional cigarette use should also be considered when planning policies for regulating e-cigarette use. For example, the implementation of excise tax on tobacco has led to significant decreases in cigarette consumption (WHO, 2010). In fact, programs designed to control and prevent cigarette smoking in the U.S. by increasing prices of cigarettes have accounted for the much of the decline in smoking (CDC, 1999; Levy, Hyland, Higbee, Rember, & Compton, 2007). In a study of adolescents among 38 countries with varying levels of income (i.e., high, middle, and low), researchers found that a 10% increase in price predicted a 15% decrease in demand for conventional cigarettes (Nikaj & Chaloupka, 2014). Similarly, in a study examining response to increases in the price of e-cigarettes, researchers found that for every 10% increase in the price of e-cigarettes, there was a corresponding 19% decrease in demand (Huang et al., 2014). These findings suggest that excise taxes may have a similar, negative effect on the demand and consumption of e-cigarettes as conventional cigarettes and should be considered by tobacco regulators and public policymakers.

The sale and advertisement of e-cigarettes to minors have recently been banned as of May 2016, which may prove to be an effective step toward prevention, particularly when considering the high level of effectiveness in banning the sale and advertisement of conventional cigarettes in reducing smoking among youth (Jason et al., 1991; Saffer & Chaloupa, 1999). The prohibition of flavored cigarettes was also implemented in response to research implicating the availability of flavored cigarettes in attracting young smokers (Klein et al., 2008; U.S. Department of Health and Human Services, 2012). Therefore, it may also be beneficial for researchers to test the effectiveness of banning

flavored e-cigarettes to determine whether this ban is effective in preventing e-cigarette use among youth. Banning e-cigarettes from being sold online may also be effective, but further research is necessary and implementation of such regulations may be difficult.

Researchers and policymakers should also consider prevention programs that have been ineffective in preventing traditional cigarette use when designing programs for the prevention of e-cigarette use. Examining ineffective programs may provide researchers and policymakers with potentially useful information regarding what may not be productive or beneficial in terms of the prevention of e-cigarette use. For example, programs that focus on social influences (i.e., increasing awareness of social influences that encourage smoking) have been ineffective in preventing traditional cigarette smoking among youth (Ary et al., 1990; Noland, Kryscio, Riggs, Linville, Ford, & Tucker, 1998; Thomas, McLellan, & Perera, 2013). Other researchers who examined school-based prevention programs found little evidence to indicate long-term prevention effectiveness (Elder et al., 1993). These results can potentially help guide researchers and policymakers in the design and implementation of future programs aimed at preventing e-cigarette use among youth, but must first be tested empirically before determining their level of effectiveness or lack thereof.

Limitations

A potential limitation of the current study is that the violation of the assumption of linearity in the logit meant that the number of friends who smoke cigarettes variable had to be removed from the analysis. Therefore, controlling for the effects of this variable was impossible even though previous research suggests that having friends who smoke

cigarettes significantly predicts e-cigarette use among adolescents (Hanewinkel &

Isensee, 2015). All analyses were conducted using self-reported data, which may be

susceptible to inaccurate self-reporting practices stemming from several possible factors,

such as the desire to engage in positive self-image management or participants' varying

interpretations of the meaning behind each item in the questionnaire. Since archival data

were used, several possibly relevant variables were not included in the analysis. For

example, adolescents' beliefs about the safety of e-cigarettes, especially when compared

to traditional cigarettes, may have had significant implications for the results of the

analyses. Another possibly important variable that was not measured is attitudes towards

the variety of flavors in which e-cigarette cartridges are available, which may be

particularly pertinent to adolescents. It is also pertinent to note that the frequency of e-

cigarette use in the current sample is low (5.6%) compared to other adolescent samples

(15.2%; Anand et al., 2015). This low prevalence of e-cigarette use in the current sample

limits the generalizability of the results. Finally, the poor reliability for the measure that

assessed for attitudes toward traditional cigarettes means that any relationship with that

measure are likely to be attenuated, and thus should be considered conservative estimates

of true population values.

Other limitations include the fact that the study was cross-sectional, which means

that causal inferences or inferences about the directionality of relationships cannot be

made. However, studies have shown that the relationship between traditional cigarette

smoking and e-cigarette use may be bidirectional. For example, in a longitudinal study of

Hispanic young adults, current use of e-cigarettes predicted later traditional cigarette

smoking among those who had never smoked traditional cigarettes before (Unger, Soto,

& Leventhal, 2016). Similar results were found among adolescents (Cardenas et al., 2016; Wills et al., 2016). Conversely, researchers from a longitudinal study of older adolescents found a strong association between previous cigarette smoking and later e-cigarette use (Lessard et al., 2014). Therefore, although our results cannot be used to infer causality, it appears that previous research has indicated a bidirectional relationship between traditional cigarette smoking and e-cigarette use, particularly among youth.

It is also important to note that lifetime e-cigarette use was a dichotomized outcome variable. Therefore, information regarding the extent or frequency of e-cigarette use among individuals in our sample who reported e-cigarette use could not be examined. Additionally, the current study's power may also be limited due to greater error that is typically introduced when dichotomizing the outcome variable. Furthermore, exposure to information about the dangers of smoking was measured using a single-item measure, and single-item measures may not always be reliable and valid. Additionally, given the sample of the study, the results may not be generalizable to populations outside of adolescents in middle and high school in California. Future studies should examine predictors of not only e-cigarette use, but also the frequency of use. Similarly, future studies should also test whether beliefs that e-cigarettes are less harmful than conventional cigarettes can explain the relationship between perceptions of the negative consequences of smoking traditional cigarettes and having ever tried e-cigarettes.

Summary and Recommendations

In summary, programs designed for the prevention of e-cigarette use should be tailored toward assisting adolescents with previous cigarette smoking experience.

Prevention programs should also be designed to address any false perceptions that conventional cigarette smoking may be beneficial or facilitate social benefits. Providing information about the dangers of conventional cigarette use through a variety of modalities may particularly be useful. Given that beliefs about the negative physical feelings associated with conventional cigarette smoking are significantly associated with having ever used an e-cigarette, educating at-risk adolescents on how e-cigarettes have similar, negative effects on an individual's physical feelings may also be beneficial. Policymakers should consider regulatory methods that have been useful in decreasing conventional cigarette smoking, particularly among youth, such as the implementation of excise tax on tobacco and banning flavored cigarettes. Future researchers should assess the relationship between adolescents' beliefs about the safety of e-cigarettes and e-cigarette use and evaluate possible predictors of the frequency of e-cigarette use.

REFERENCES

Abreu –Villaça,Y., Filgueiras, C. C., Correa-Santos, M., Cavina, C. C., Naiff, V. F., Krahe, T. E., … Ribeiro-Carvalho, A. (2015). Tobacco smoke containing high or low levels of nicotine during adolescence: Effects on novelty-seeking and anxiety-like behaviors in mice. *Psychopharmacology, 232*(10), 1693-1703. doi: 10.1007/s00213-014-3801-1

Ajzen, I., & Fishbein, M. (1977). Attitude–behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84*, 888–918.

Ambrose, B. K., Rostron, B. L., Johnson, S. E., Portnoy, D. B., Apelberg, B. J., Kaufman, A. R., & Choiniere, C. J. (2014). Perceptions of the relative harm of cigarettes and e-cigarettes among U.S. youth. *American Journal of Preventative Medicine, 47*(2), S53-S60.

American Cancer Society. (2015). *E-cigarettes may be as addictive as traditional ones*. Retrieved from http://www.acs.org/content/acs/en/pressroom/presspacs/2015/acs-presspac-july-22-2015/e-cigarettes-may-be-as-addictive-as-traditional-ones.html

Amos, A., Wiltshire, S., Haw, S., & McNeill, A. (2006). Ambivalence and uncertainty: Experiences of and attitudes towards addiction and smoking cessation in the mid-to-late teens. *Health Education Research, 21*(2), 181-191.

Anand, V., McGinty, K. L., O'Brien, K., Guenthner, G., Hahn, E., & Martin, C. A. (2015). E-cigarette use and beliefs among urban public high school students in North Carolina. *Journal of Adolescent Health, 57*(1), 46-51. doi:10.1016/j.jadohealth.2015.03.018

Andrews, J. C., Netemeyer, R. G., Burton, S., Moberg, D. P., & Christiansen, A. (2004). Understanding adolescent intentions to smoke: An examination of relationships among social influence, prior trial behavior, and antitobacco campaign advertising. *Journal of Marketing, 68*, 110-123.

Arnett, J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review, 12*, 339–373. doi:10.1016/0273-2297(92)90013-R

Ary, D. V., Biglan, A., Glasgow, R., Zoref, L., Black, C., Ochs, L., … Lichstenstein, E. (1990). The efficacy of social-influence prevention program versus "standard care": Are new initiatives needed? *Journal of Behavioral Medicine, 13*(3), 281-296.

Aryal, U. R. (2013). Perceived risks and benefits of cigarette smoking among Nepalese adolescents: A population-based cross-sectional study. *BMC Public Health, 13*, 187.

Backinger, C. L., Fagan, P., Matthews, E., & Grana, R. (2003). Adolescent and young adult tobacco prevention and cessation: Current status and future directions. *Tobacco Control, 12*(4), 46–53. doi:10.1136/tc.12.suppl_4.iv46

Bottorff, J. L., Johnson, J. L., Moffat, B., Grewal, J., Ratner, P. A., & Kalaw, C. (2004). Adolescent constructions of nicotine addiction. *Canadian Journal of Nursing Research, 36*(1), 22-39.

Callahan-Lyon, P. (2014). Electronic cigarettes: Human health effects. *Tobacco Control, 23*, ii36-ii40. doi:10.1136/tobaccocontrol-2013-051470

Camenga, D. R., Delmerico, J., Grace, K., Cavallo, D., Hyland, A., Cummings, K. M., & Krishnan- Sarin, S. (2014). Trends in use of electronic nicotine delivery systems by adolescents. *Addictive Behaviors, 39*, 338-340.

Cameron, J. M., Howell, D. N., White, J. R., Andrenyak, D. M., Layton, M. E., & Roll, J. M. (2014). Variable and potentially fatal amounts of nicotine in e-cigarette nicotine solutions. *Tobacco Control, 23*, 77-78, doi: 10.1136/tobaccocontrol-2012-050604

Cardenas, V. M., Evans, V. L., Balamurugan, A, Faramawi, M. F., Delongchamp, R. R., & Wheeler, J. G. (2016). Use of electronic nicotine delivery systems and recent initiation of smoking among US youth. *International Journal of Public Health*, *61*(2), 237-241.

Carroll Chapman, S. L., & Wu, L. T. (2014). E-cigarette prevalence and correlates of use among adolescents versus adults: A review and comparison. *Journal of Psychiatric Research, 54*, 43-54.

Centers for Disease Control and Prevention (1999). Decline in cigarette consumption following implementation of a comprehensive tobacco prevention and education program -- Oregon, 1996-1998. *Morbidity and Mortality Weekly Report, 48*,140-143.

Centers for Disease Control and Prevention. (2015). *E-cigarette use triples among middle and high school students in just one year*. Retrieved from http://www.cdc.gov/media/releases/2015/p0416-e-cigarette-use.html

Chambers, R. A., Taylor, J. R., & Potenza, M. N. (2003). Developmental neurocircuitry of motivation in adolescence: A critical period of addiction vulnerability. *American Journal of Psychiatry, 160*(6), 1041-1052. http://dx.doi.org/10.1176/appi.ajp.160.6.1041

Chassin, L., Presson, C., Seo, D. C., Sherman, S. J., Macy, J., Wirth, R. J., & Curran, P. (2008). Multiple trajectories of cigarette smoking and the intergenerational transmission of smoking: A multigenerational, longitudinal study of a Midwestern

community sample. *Health Psychology, 27*, 819–828. doi:10.1037/0278-6133.27.6.819

Chen, X., Stanton, B., Fang, X., Li., X., Lin, D., Zhang, J., Liu, & Yang, H. (2006). Perceived smoking norms, socioenvironmental factors, personal attitudes and adolescent smoking in China: A mediation analysis with longitudinal data. *Journal of Adolescent Health, 38*(4), 359-368. doi:10.1016/j.jadohealth.2005.03.010

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). Applied multiple regression/correlation analysis for the behavioral sciences, third edition. Mahwah, NJ: Lawrence Erlbaum Associates.

Corey, C., Wang, B., Johnson, S. E., Apelberg, B., Husten, C., King, B. A., et al. (2013). Electronic cigarette use among middle and high school students - United States, 2011-2012. *Morbidity and Mortality Weekly Report, 62*(35), 729-730.

Dawkins, L., Turner, J., Roberts, A., & Soar, K. (2013). 'Vaping' profiles and preferences: an online survey of electronic cigarette users. *Addiction, 108*, 1115-1125.

Dockrell, M., Morison, R., Bauld, L., & McNeill, A. (2013). E-cigarettes: prevalence and attitudes in Great Britain. *Nicotine & Tobacco Research, 15*, 1737-1744.

Dhungel, B., & Bhandari, N. (2015). Perceptions of risks and benefits of smoking among adolescents of Glacier International College. *Open Access Library Journal, 2*, 1-13. doi: http://dx.doi.org/10.4236/oalib.1101160.

DiFranza, J. R., Savageau, J. A., Fletcher, K., O' Loughlin, J., Pbert, L., Ockene, J. K., … Wellman, R. J. (2007). Symptoms of tobacco dependence after brief intermittent use: The development and assessment of nicotine dependence in youth-2 study. *Archives of Pediatrics and Adolescents Medicine, 161*, 704-710.

Doest, L., Dijkstra, A., Gebhardt, W. A., & Vitale, S. (2009). Cognition about smoking and not smoking in adolescence. *Health Education Behavior, 36*(4), 660-672.

Dunn, M. E. & Goldman, M. S. (2000). Drinking-related differences in expectancies of children assessed as first associates. *Alcoholism: Clinical and Experimental Research, 24*(11), 1639-1946. http://psycnet.apa.org/doi/10.1111/j.1530-0277.2000.tb01965.x

Dwyer, J. B., McQuown, S. C., & Leslie, F. M. (2009). The dynamic effects of nicotine on the developing brain. *Pharmacology & Therapeutics, 122*(2), 125-139. doi: 10.1016/j.pharmthera.2009.02.003.

Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Flint, K. H., Hawkins, J., …Wechsler, H. (2012). Youth risk behavior surveillance – United States, 2011. *Morbidity and Mortality Weekly Report, 61*(4), 1-162.

Elder, J. P., Wildey, M., de Moor, C., Sallis, J. F., Eckhardt, L., Edwards, C., … Johnston D. (1993). The long-term prevention of tobacco use among junior high school students: classroom and telephone interventions. *American Journal of Public Health, 83*(9), 1239-1244.

Emory, K. T., Messer, K., Vera, L., Ojeda, N., Elder, J. P., Usita, P., & Pierce, J. P. (2015). Receptivity to cigarette and tobacco control messages and adolescent smoking initiation. *Tobacco Control, 24*, 281-284. doi:10.1136/tobaccocontrol-2013-051187

Ewijk, H., Groenman, A. P., Zwiers, M. P., Heslenfeld, D. J., Faraone, S. V., Harman, C. A., … Oosterlaan, J. (2015). Smoking and the developing brain: Altered white matter microstructure in attention-deficit/hyperactivity disorder and health controls. *Human Brain Mapping, 36*(3), 1180-1189. doi: 10.1002/hbm.22695

Fairchild, A. L., Bayer, R., & Colgrove, J. (2014). The renormalization of smoking? E-cigarettes and the tobacco "endgame."*New England Journal of Medicine, 370*(4), 293-295.

Farsalinos, K. E., Romagna, G., Tsiapras, D., Kyrzopoulos, S., & Voudris, V. (2014). Characteristics, perceived side effects and benefits of electronic cigarette use: A worldwide survey of more than 19,000 consumers. *International Journal of Environmental Research and Public Health, 11*, 4356-4373. doi: 10.3390/ijerph110404356

FDA Deeming Tobacco Products to be Subject to Federal Food, Drug, and Cosmetic Act, 21 C.F.R. § 1100, 1140, and 1143 (2016).

Goal, R., Durand, E., Trushin, N., Prokopczyk, B., Foulds, J., Elias, R. J., & Richie, J. P. (2015). Highly reactive free radicals in electronic cigarette aerosols. *Chemical Research in Toxicology, 28*(9), 1675-1677.

Goniewicz, M.L., Knysak, J., Gawron, M., Kosmider, L., Sobczak, A., Kurek, J., & Benowitz, N. (2013). Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tobacco Control*. Advance online publication. doi:10.1136/tobaccocontrol-2012-050859a

Goniewicz, M. L., Kuma, T., Gawron, M., Kynsak, J., & Kosminder, L. (2013). Nicotine levels in electronic cigarettes. *Nicotine & Tobacco Research, 15*, 158-166

Goniewicz, M. L., & Zielinska-Danch, W. (2012). Electronic cigarette use among teenagers and young adults in Poland. *Pediatrics, 130*(4), e879-e885.

Grana, R. A. & Ling, P. M. (2014). "Smoking Revolution": A content analysis of electronic cigarettes retail websites. *American Journal of Preventative Medicine, 46*, 395-403.

Guilamo-Ramos, V., Jaccard, J., Dittus, P., Bouris, A., Holloway, I., & Casillas, E. (2007). Adolescent expectancies, parent-adolescent communication and intentions to have sexual intercourse among inner-city, middle school youth. *Annals of Behavioral Medicine, 34*(1), 56-66.

Halpern-Felsher, B. L., Ramos, M. E., & Cornell, J. L. (2007). Adolescents' and young adults' perceptions of tobacco use: A review and critique of the current literature. In: R. J.Bonnie, K.Stratton, & R. B.Wallace (Eds.), *Ending the tobacco problem: A blueprint for the nation* (pp. 478–494). Washington, DC: National Academies Press.

Hanewinkel, R., & Isensee, B. (2015). Risk factors for e-cigarette, conventional cigarette, and dual use in German adolescents: A cohort study. *Preventative Medicine, 74*, 59-62. doi:10.1016/j.ypmed.2015.03.006

Huang, J., Tauras, J., & Chaloupka, F. J. (2014). The impact of price and tobacco control policies on the demand for electronic nicotine delivery systems. *Tobacco Control , 23*(3), iii41–47.

Jason, L. A., Ji, P. Y., Anes, M. D., & Birkhead, S. H. (1991). Active enforcement of cigarette control laws in the prevention of cigarette sales to minors. *JAMA, 266*(22), 3159-3161.

Joffer, J., Burell, G., Bergström, E., Stenlund, H., Sjörs, L., & Jerdén, L. (2014). Predictors of smoking among Swedish adolescents. *BMC Public Health, 14*, 1-9. doi:10.1186/1471-2458-14-1296

Kendler, K. S., Myers, J., Damaj, M. I., & Chen, X. (2013). Early smoking onset and risk for subsequent nicotine dependence: A monozygotic co-twin control study. *American Journal of Psychiatry, 170*, 408-413.

Klein, S. M., Giovino, G. A., Barker, D. C., Tworek, C., Cummings, K. M., & O' Connor, R. J. (2008). Use of flavored cigarettes among older adolescents and adult smokers: United States, 2004-2005. *Nicotine & Tobacco Research, 10*(7), 1209-1214. doi: 10.1080/14622200802163159

Klein, H., Sterk, C. E., & Elifson, K. W. (2013). Initial smoking experiences and current smoking behaviors and perceptions among current smokers. *Journal of Addiction, 2013*, 1-9. http://0-dx.doi.org.catalog.llu.edu/10.1155/2013/491797

Kong, G., Morean, M. E., Cavallo, D. A., Camenga, D. R., & Krishnan-Sarin, S. (2015). Reasons for electronic cigarette experimentation and discontinuation among

adolescents and young adults. *Nicotine & Tobacco Research, 17*(7), 847-854. doi: 10.1093/ntr/ntu257

Krishnan-Sarin, S., Morean, M. E., Camenga, D. R., Cavallo, D. A., & Kong, G. (2015). E-cigarette use among high school and middle school adolescents in Connecticut. *Nicotine & Tobacco Research*. *17*(7), 810-818. doi: 10.1093/ntr/ntu243

Lantz, P. M. (2003). Smoking on the rise among young adults: Implications for research and policy. *Tobacco Control, 12*, i60-i70.

Lee, S., Grana, R. A., & Glantz, S. A. (2014). Electronic cigarette use among Korean adolescents: a cross-sectional study of market penetration, dual use, and relationship to quit attempts and former smoking. *Journal of Adolescent Health, 54*, 684-690. doi: 10.1016/j.jadohealth.2013.11.003

Lerner, C. A., Sundar, I. K., Yao., H., Gerloff, J., Ossip, D. J., McIntosh, S., Robinson, R. & Rahman, I. Vapors produced by electronic cigarettes and e-juices with flavorings induce toxicity, oxidative stress, and inflammatory response in lung epithelial cells in mouse lung. *PLOS One, 10*(2), e0116732. doi:10.1371/journal.pone.0116732

Lessard, J., Henrie, J., Livingston, J. A., Leonard, K. E., Colder, C. R., & Eiden, R. D. (2014). Correlates of ever having used electronic cigarettes among older adolescent children of alcoholic fathers. *Nicotine & Tobacco Research, 16*(12), 1656-1660.

Leventhal, A. M., Strong, D. R., Kirkpatrick, M. G., Unger, J. B., Sussman, S., Riggs, N. R., … Audrain-McGovern, J. (2015). Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *Journal of the American Medical Association, 314*(7), 700-707. doi:10.1001/jama.2015.8950.

Levy, D. T., Hyland, A., Higbee, C., Remer, L., & Compton, C. (2007). The role of public policies in reducing smoking prevalence in California: results from the California tobacco policy simulation model. *Health Policy, 82*, 167-185.

Mackey, T. K., Miner, A., & Cuomo, R. E. (2015). Exploring the e-cigarette e-commerce marketplace: Identifying internet e-cigarette marketing characteristics and regulatory gaps. *Drug and Alcohol Dependence*. Advance online publication. doi: 10.1016/j.drugalcdep.2015.08.032

Michaelidou, N., Dibb, S., & Ali, H. (2008). The effect of health, cosmetic and social anitsmoking information themes on adolescents' beliefs about smoking. International *Journal of Advertising, 27*(2), 235-250.

Milam, J. E., Sussman, S., Ritt-Olson, A., & Dent, C. W. (2000). Perceived invulnerability and cigarette smoking among adolescents. *Addictive Behavior, 25*(1), 71-80.

Moffitt, T. E. (1993). Adolescence-limited and life-course-persistent anti-social behavior: A developmental taxonomy. *Psychological Review,100*, 674–701. doi:10.1037/0033-295X.100.4.674

Morrell, H. E. R., Lapsley, D. K., & Halpern-Felsher, B. L. (2015). Subjective invulnerability and perceptions of tobacco-related benefits predict adolescent smoking behavior. *Journal of Early Adolescence*. Advance online publication. doi: 10.1177/0272431615578274

Morrell, H. E. R., Song, A. V., & Halpern-Felsher, B. L. (2010). Predicting adolescent perceptions of the risks and benefits of cigarette smoking: A longitudinal investigation. *Health Psychology, 29*(6), 610-617. doi: 10.1037/a0021237

Nichter, M., Nichter, M., Vuckovic, G., Quintero, G., & Ritenbaugh, C. (1997). Smoking experimentation and initiation among adolescent girls: Qualitative and quantitative findings. *Tobacco Control, 6*, 285-295. doi:10.1136/tc.6.4.285

Nikaj, S. & Chaloupka, F. J. (2014). The effect of prices on cigarette use among youths in the global youth tobacco survey. *Nicotine Tobacco Research, 16*(1), S16 –S23.

Noel, J. K., Rees, V. W., & Connolly, G. N. (2011). Electronic cigarettes: A new 'tobacco' industry? *Tobacco Control, 20*(1), 81. doi: 10.1136/tc.2010.038562

Noland, M. P., Kryscio, R. J., Riggs, R. S., Linville, L. H., Ford, V. Y., & Tucker, T. C. (1998). *American Journal of Public Health, 88*(12), 1862-1865.

O'Connor, R. M., Fite, P. J., Nowlin, P. R., & Colder, C. R. (2007). Children's beliefs about substance use: An examination of age differences in implicit and explicit cognitive precursors of substance use initiation. *Psychology of Addictive Behaviors, 21*(4), 525-533.

Pechmann, C., Zhao, G., Goldberg, M. E., & Reibling, E. T. (2003). What to convey in antismoking advertisements for adolescents: the use of protection motivation theory to identify effectives message themes. *Journal of Marketing, 67*, 1-18.

Penn State Milton S. Hershey Medical Center. (2015, December 2). Potentially dangerous molecules detected in e-cigarette aerosols. *ScienceDaily*. Retrieved March 25, 2016 from www.sciencedaily.com/releases/2015/12/151202095435.htm

Pepper, J. K., Reiter, P. L., McRee, A. L., Cameron, L.D., Gilkey, M. B., & Brewer, N. T. (2013). Adolescent males' awareness of and willingness to try electronic cigarettes. *Journal of Adolescent Health, 52*, 144-150.

Pollay, R. W., Siddarth, S., Siegal, M., Haddix, A., Merritt, R. K., Giovino, G. A., & Eriksen, M. P. (1996). The last straw? Cigarette advertising and realized market shares among youths and adults, 1979-1993. *Journal of Marketing, 60*, 1-16.

Polosa, R., Caponnetto, P., Morjaria, J. B., Papale, G., Campagna, D., & Russo, C. (2011). Effect of an electronic nicotine delivery device (e-Cigarette) on smoking reduction and cessation: A prospective 6-month pilot study. *BMC Public Health, 11*, 1-12.

Primack, B. A., Soneji, S., Stoolmiller, M., Fine, M. J., & Sargent, J. D. (2015). Progression to traditional cigarette smoking after electronic cigarette use among U.S. adolescents and young adults. *JAMA Pediatrics*. Advance online publication. doi:10.1001/jamapediatrics.2015.1742

Rise, J. Kovac, V., Kraft, P., & Moan, I. (2008). Predicting the intention to quit smoking and quitting behavior: Extending the theory of planned behavior. *British Journal of Health Psychology, 13*, 291-310. doi: 10.1348/135910707X187245

Roditis, M. L., & Halpern-Felsher, B. (2015). Adolescents' perceptions of risks and benefits of conventional cigarettes, e-cigarettes, and marijuana: A qualitative analysis. *Journal of Adolescent Health, 57*(2), 179-185. doi:10.1016/j.jadohealth.2015.04.002

Rodriguez, D., Romer, D., & Audrain-McGovern, J. (2007). Beliefs about the risks of smoking mediate the relationship between exposure to smoking and smoking. *Psychosomatic Medicine*, *69*, 106–113.

Romer, D., & Jamieson, P. (2001). Do adolescents appreciate the risks of smoking? Evidence from a national survey. *Journal of Adolescent Health, 29*(1), 12-21. doi: 10.1016/S1054-139X(01)00209-9

Saffer, H. & Chaloupka, F. (1999). Tobacco advertising: economic theory and international evidence. *National Bureau of Economic Research Working Paper 6958*. doi: http://www.nber.org/papers/w6958

Siegal, M., & Biener, L. (2000). The impact of an anti-smoking media campaign on progression to established smoking: Results of a longitudinal youth study. *American Journal of Public Health, 90*(3), 380-386.

Sheppard, J. A., Klein, W. M. P., Waters, E. A., & Weinstein, N. D. (2013). Taking shock of unrealistic optimism. *Perspectives on Psychological Science, 8*(4), 395-441.

Sherman, S. J., Chassin, L., Presson, C., Seo, D., & Macy, J. T. (2009). The intergenerational transmission of implicit and explicit attitudes toward smoking: Predicting adolescent smoking initiation. *Journal of Experimental Social Psychology, 45*(2), 313-319.

Slotkin, T. A. (2011). Nicotine and the adolescent brain: insights from an animal model. *Neurotoxicology and Teratology, 24*(3), 369-384.

Smith, B. N., Bean, M. K., Mitchell, K. S., Speizer, I. S., & Fries, E. A. (2007). Psychosocial factor associated with non-smoking adolescents' intentions to smoke. *Health Education Research, 22*(2), 238-247.

Song, A. V., Morrell, H. E. R., Cornell, J. L., Ramos, M. E., Biehl, M., Kropp, R. Y., & Halpern- Felsher, B. L. (2009). Perceptions of smoking-related risks and benefits as predictors of adolescent smoking initiation. *American Journal of Public Health*, *99*, 487–492.

Sutfin, E. L., McCoy, T. P., Morrell, H. E. R., Hoeppner, B. B., & Wolfson, M. (2013). Electronic cigarette use by college students. *Drug and Alcohol Dependence, 131*, 214-221.

Thomas, R. E., McLellan, J., & Perera, R. (2013). School-based programmes for preventing smoking. Cochrane Database of Systemic Reviews, 4. doi: 10.1002/14651858.CD001293.pub3.

Trtchounian, A. & Talbot, P. (2011). Electronic nicotine delivery systems: is there a need for regulation? *Tobacco Control*, *20*, 47-52. doi: 10.1136/tc.2010.037259

Unger, J. B., Soto, D. W., Leventhal, A. (2016). E-cigarette use and subsequent cigarette and marijuana use among Hispanic young adults. *Drug and Alcohol Dependence, 163*(1), 261-264.

U.S. Department of Health and Human Services. (2012). Preventing tobacco use among youth and young adults: A report of the surgeon general. Retrieved from http://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use/

Vardavas, C. I., Anagnostopoulos, N., Kougias, M., Evangelopoulou, V., Connolly, G. N., & Behrakis, P. K. (2012). Shortterm pulmonary effects of using an electronic cigarette: impact on respiratory flow resistance, impedance, and exhaled nitric oxide. *Chest, 141*, 1400–1406.

Walsh, R. A., & Tzelepis, F. (2007). Adolescents and tobacco use: Systematic review of qualitative research methodologies and partial synthesis of findings. *Substance Use & Misuse, 42*(8), 1269-1321. doi:10.1080/10826080701204904

Wang, C., Henley, N., & Donovan, R. J. (2004). Exploring children's conceptions of smoking addiction. *Health Education Research, 19*(6), 626-634.

Wang ,Q. S., Ping, P., Zhao, X. J, Chu, G. Q., Sun, J. H., & Chen, C. H. (2012). Thermal runaway caused fire and explosion of lithium ion battery. *Journal of Power Sources, 208*, 210–24

Williams, M., Villarreal, A., Bozhilov, K., Lin, S., & Talbot, P. (2013). Metal and silicate particles including nanoparticles are present in electronic cigarette cartomizer fluid and aerosol. *PLOS One, 8*, 1-11.

Wills, T. A., Knight, R., Sargant, J. D., Gibbons, F. X., Pagano, I., & Williams, R. J. (2016). Longitudinal study of e-cigarette use and onset of cigarette smoking among high school students in Hawaii. *Tobacco Control*. Advance online publication. doi:10.1136/tobaccocontrol-2015-052705

Wills, T. A., Knight, R., Williams, R. J., Pagano, I., & Sargent, J. D. (2015). Risk factors for exclusive e-cigarette use and dual e-cigarette use and tobacco use in adolescents. *Pediatrics, 135*(1), e43-e51.

White, J., Li, J., Newcombe, R., & Walton, D. (2015). Tripling use of electronic cigarettes among New Zealand adolescents between 2012 and 2014. *Journal of Adolescent Health, 56*(5), 522-528. doi: 10.1016/j.jadohealth.2015.01.022

Wolburg, J. M. (2006). College students' responses to antismoking messages: Denial, defiance, and other boomerang effects. *Journal of Consumer Affairs, 40*(2), 294-323.

World Health Organization. (2010). *WHO technical manual on tobacco tax administration*. Retrieved from http://www.who.int/tobacco/publications/tax_administration/en/

Yu, S., Koplan, J., Eriksen, M. P., Yao, S., Redmon, P., Song, J., … Cheng, H. (2015). The effects of antismoking messages from family, school, and mass media on smoking behavior and smoking intention among Chinese adolescents. *Journal of Health Communication: International Perspectives, 20*(11), 1255-1263. doi: 10.1080/10810730.2015.1018561

Zhu, S. H., Sun, J. Y., Bonnevie, E., Cummins, S. E., Gamst, A., Yin, L., & Lee. M. (2014). Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. *Tobacco Control, 23*, iii3-iii9. doi: 10.1136/tobaccocontrol-2014-051670